

REMARKS/ARGUMENTS

The Drawing

By the present amendment, the drawing has been amended to provide the legend "Prior Art" for Figs. 1a and 1b.

With respect to the matter raised in Paragraph 5 of the Office Action, as described at page 5, lines 31, 32 and page 7, lines 24, 25 of the specification, the method of the present invention may be carried out by, and the apparatus includes, an appropriately programmed digital signal processing unit 230. It is therefore believed that the subject matter presently included in the textual description and claims, and noted by the Examiner in Paragraph 5 of the Office Action, can be most illustratively shown in the drawing by insertion in the flow charts of Fig. 3. A revised flow chart of Fig. 3a is provided for this purpose.

Specifically, Fig. 3a has been amended to include the comparison and identification aspects described at page 3, line 10 and, in detail, at page 6, lines 8-20, of the specification, as filed. In view of this textual description in the application, as filed, no new matter is introduced by the inclusion of a graphic description counterpart in the drawing.

Fig. 3a is also amended to show the downsampling step as including low-pass filtering of the first, or high rate sequence, as described in original claim 9 and page 7, lines 8-10 and page 8, lines 23-27 of the specification. The low pass filtering described in claim 10, of the application, as filed, is already shown in Fig. 3c by reference numeral 350.

With respect to the structure of the second sample sequence, as noted at page 7, lines 23 and 24, the second sample sequence forms the digital presentation of the electric signal from which the interference or artifact has been removed. Hence, its particular structure will depend on the nature of the original electric signal, such as an ECG signal, from which it is derived.

It is respectfully requested that the objection to the drawing be withdrawn.

The Claims - Formal Matters

The language of claim 15, formerly claim 1, has been amended in a manner believed to respond to the helpful comments of the Examiner in connection with the rejection under 35 U.S.C. §112(2). Specifically, the selection and downsampling steps of the method formerly found in claim 1 has been amended to more appropriately describe these steps of the method using language shown in the drawings and found at page 3, line 10 and page 6, lines 8-20. This is believed to clarify the language of the claim, as well as to correlate with the description of the invention in the disclosure.

Claim 20, formerly claim 4, has been amended to place the claim more clearly in method format and to provide the indefinite article "a" with respect to the slew rate. Similar steps have been taken with respect to claim 29, formerly claim 7.

Claims 15 and 32 have also been amended to provide the appropriate punctuation, as noted by the Examiner in the claim objections. The other apparatus claims have been amended in a manner similar to the method claims.

Withdrawal of the formal objection/rejection of the claims, is respectfully requested.

The Present Invention

As noted in the specification of the present application, the present invention is directed to a method and apparatus for removing undesired interference, such as noise, from an electrical signal, such as an ECG signal, so that the remaining signal provides an accurate representation of the electrocardiographic, or other, data. The invention finds use in the electrocardiographic field, in connection with the removal of interference created by magnetic resonance imaging device.

In the invention, the electrical signal is sampled at a first sampling frequency to obtain a first sequence of samples. In the first sequence of samples, samples are identified on the basis of their interference (artifact) content. This may be carried out by comparison of a sample to a reference signal to preferably identify samples that are artifact free. Thereafter, a downsampling is carried out to obtain a second sequence of samples from the

identified samples from which a digital presentation of the electrical signal with the interference removed may be provided. All samples of the first sequence may be provided for downsampling with only those samples previously identified being subjected to downsampling process. Or, only the identified, artifact free samples may be provided for downsampling. The downsampling frequency is less than the initial sampling frequency. Appropriate filtering may be provided during or following the downsampling.

A reference signal for use in the identification step/means may be obtained from the first sequence as by limiting a skew rate in the sequence. Or, the reference signal may comprise an external one.

Hum components from alternating current supply lines may be removed by estimating the power supply hum and deducting same from the first sequence of samples.

The Claims - Substantive Matters

In the Office Action of March 23, 2005, examined independent claims 1 and 11, and the claims dependent thereon, were rejected under 35 U.S.C. §103 on U.S. Patent 4,483,346 to Slavin, U.S. Patent 5,924,980 to Coetzee, and U.S. Patent 5,048,535 to Maruyama.

The Slavin patent is directed to a portable electrocardiograph in which digitized ECG data is read into a random access memory (RAM) and thereafter read out to drive a printer or other output device. Differences in the rates at which the data is read into the RAM and read out of the RAM cause data to be stored in the RAM in the manner of a buffer. For a situation in which data is being read into the RAM at a faster rate than it is being read out, the read out process continues after the completion of the data input to the RAM, as noted at Col. 6, lines 26, 27.

In contrast to the present invention, there is no comparison or identification carried out on the data read into and out of the RAM so that all ECG signal data read into the RAM will eventually be read out of the RAM to drive the output device such as a printer, any differences in the input rate and output rate being accommodated by the buffer function of the RAM.

The step/means in the claims in the application calling for an identification and downsampling of certain samples in the first sequence of samples clearly distinguishes the claimed subject matter over the subject matter of the Slavin reference.

The following is to be noted with respect to the pertinent portions of the secondary Coetzee reference, i.e. those dealing with the use of a reference signal. As noted above, the method/apparatus of the present invention employs a reference signal to identify samples of the first data sequence that will be ultimately subjected to downsampling to generate an output signal comprising a digital presentation of the input electrical signal with the interference removed. This approach differs from any teaching or suggestion of the Coetzee reference. This reference is directed to an adaptive filtering technique, as described in the Summary of Invention, Col. 4, lines 9-24, in which the acquired physiological signal is used in a feedback manner to iteratively adjust a synthetic reference signal so that output of the filter progressively becomes a more accurate approximation of the data component of the physiological signal so that it may be used as a reconstruction of a reduced noise acquired physiological signal. The acquired physiological signal is processed to identify signal sections having a high confidence of being free of undesired noise components. However, these signal sections are then used in the feedback manner to model the synthetic reference signal to improve the performance of the adaptive filter.

The present invention in which the identified, artifact free samples of the electric signal are subjected to subsequent downsampling to generate an interference suppressed output signal is distinctly different from the adaptive filter of the Coetzee reference.

Hence, the Coetzee reference does not overcome the shortcomings of the main Slavin reference.

The Maruyama reference is directed to a QRS complex detector for determining the heart rate of a subject. While the removal of hum is generally discussed in the reference as at step P2, and as element 1, there is no teaching of the specific details set out in claims 29, 30 and 38 of the present application.

Appln. No. 10/724,347
Amendment dated July 25, 2005
Reply to Office Action of March 23, 2005

The additional references cited in the Office Action, but not applied, are not believed to alter the patentability of the claimed subject matter urged above.

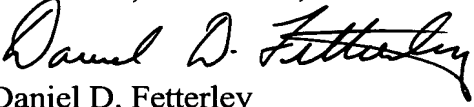
Withdrawal of the rejection of the claims is therefore respectfully requested.

The amendment is accompanied by an Information Disclosure Statement making of record the references cited in the Search Report of the European priority application and other materials.

Passage of this application to allowance is respectfully requested.

Respectfully submitted,

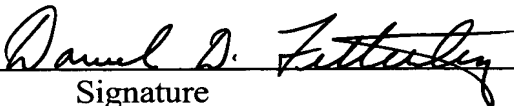
ANDRUS, SCEALES, STARKE & SAWALL, LLP


Daniel D. Fetterley
(Reg. No. 20,323)

100 East Wisconsin Avenue, Suite 1100
Milwaukee, Wisconsin 53202
(414) 271-7590

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, Mail Stop - Fee, P.O. Box 1450, Alexandria, VA 22313-1450 on the 25th day of July, 2005.

<u>Daniel D. Fetterley</u>	<u>20,323</u>
Name	Reg. No.
<u></u>	<u>7/25/05</u>
Signature	Date

Appln. No. 10/724,347
Amendment dated July 25, 2005
Reply to Office Action of March 23, 2005

Amendments to the Drawings:

The attached sheets of drawings include changes to Figs. 1 and 3a. These sheets, which include Figs. 1 and 3a, replace the original sheets including Figs. 1 and 3a.

Attachment: Replacement Sheets